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Increasing students' higher order thinking skills in science learning through discovery learning assisted by e-worksheet based on Google Docs

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Abstract: This study aims to determine the optimal application of discovery learning assisted by an Electronic Worksheet based on Google Docs and to determine the improvement of HOTS of students in Junior High School Students. This research was classroom action research (CAR) with a spiral design by Kemmis and MC Taggart, including the stages of Planning, Implementation, Observation, and Reflection. Learning was carried out in two cycles, each consisting of two meetings. The research subjects were 32 students in the academic year 2021/2022. Data were collected using an instrument of learning implementation observation and test. Data were analyzed descriptively (quantitatively and qualitatively), and inferential statistics to determine the achievement of success indicators. The results show that implementing the discovery learning model has reached the excellent category in cycle II. The results prove that s 78% of students have reached the minimum completeness criteria for HOTs. In addition, there is a significant difference in the average pre-test and post-test scores in the medium category in cycle II. Therefore, it can be concluded that this media can improve students' HOT.

Keywords: CAR, Discovery learning, E-worksheet, Science Learning

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INTRODUCTION

Life in the 21st century demands various skills that one must master. Essential skills in the 21st century contain specific skills that need to be empowered in learning activities, such as critical thinking, problem-solving, metacognition, communication, collaboration, innovation and creation, information literacy, and various other skills (Zubaidah, 2016). These 21st-century skills require deeper thinking than simply remembering and understanding. Higher-order thinking skills are demands that students must meet. Higher-order thinking is the ability to connect, manipulate, and transform knowledge and experience to think critically and creatively to make decisions and solve problems in new situations (Rofiah et al., 2013).

The results of TIMSS 2014 and 2018 show that, on average Indonesian students are only able to answer questions of understanding (knowing) with a higher level of truth compared to questions of applying (applying) and reasoning (reasoning), which are the central part of the cognitive domain applied to TIMSS (Hakim et al., 2021). This is unfortunate, considering that higher-order thinking skills (HOTS) can improve students' ability to compete at higher education levels and prepare students to compete in the future (Asphar et al., 2021).

The same thing happened to the students of class VIII A of SMP Negeri 4 Pakem. Based on the results of the initial assessment using the HOTS ability assessment questions, it shows that the average score achieved is only 68.8 of 100, with the number of students scoring above the minimum completeness criteria (KKM) only 7 students, or 22%. In addition, observations on online science learning during the Covid-19 pandemic at SMP Negeri 4 Pakem have not led to the development of HOTS. When learning is carried out synchronously using video conferencing, it appears that activities are dominated by explanations of material using PowerPoint by teachers and minimal discussion

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activities that can practice students' thinking skills. During the discussion, most of the students were also less actively involved. Many students turned off the camera and were reluctant to respond to questions or teacher statements. In addition, they were learning asynchronously through Google Classroom, which contains materials and assignments. The worksheet guides the tasks given, but unfortunately, the worksheet is mostly practiced questions, with most of the questions not meeting the HOTS category. Given the number of assignments and homework given for various subjects, some students are often late or do not even complete the assignments given by the teacher.

Based on these problems, efforts to improve the learning process and media that lead to the development of HOTS need to be made. In terms of the learning process, teachers need to use models that can increase the activeness and involvement of students and practice their HOTS abilities. Several models can be used, including the inquiry model, as recommended by Tambun et al. (2021). Another problem-based learning (PBL) research was carried out by Kurniasih et al. (2020). Muhajir & Untari (2019) also conducted a similar study of project-based learning (PjBL) as well as discovery learning that has been tested by Putri et al. (2019).

Furthermore, this study focused on solving students' online learning conditions by implementing the discovery learning model. Discovery learning is a learning model that can increase students' involvement in finding concepts and principles independently or in groups through problem stimulation planned by the teacher (Syahmel and Jumadi, 2019). This model has several advantages, including 1) increasing the experience of students in learning, 2) providing opportunities for students to be closer to sources of knowledge other than books, 3) exploring the creativity of students, and 4) being able to increase students' self-confidence. Students and 5) increasing student cooperation (Putrayasa, Syahruddin, & Margunayasa, 2014). This model's application is expected to provide the most comprehensive opportunity for students to interact with problems that can stimulate their thinking in identifying and formulating problems and seeking answers through disclosure activities which will undoubtedly involve higher-order thinking skills.

For the application of discovery learning to run optimally, worksheet media is needed to guide student learning activities. The electronic worksheet is the right choice for online learning conditions and is expected to overcome the weaknesses of the worksheet used so far, as described previously. Making electronic worksheets can take advantage of various applications. However, the electronic worksheet with Google Docs is the easiest to use and operate. Google Docs has several advantages, including facilitating students to study independently or in groups, form communication networks and interact with group members (Astuti et al., 2021). Electronic worksheets based on Google Docs will make students more active in the learning process. Working on the worksheet can be done in real-time so the teacher can better monitor and guide it. This will create effective interaction between teachers and students so that students are expected to be able to find concepts independently with the help of the electronic worksheet (Relia, 2016). Therefore, classroom action research was conducted with the objectives of 1) knowing the optimal application of the discovery learning model assisted by electronic worksheet based on Google Docs in improving students' HOTS abilities, and 2) knowing the improvement of the HOTS abilities of class VIII A students of SMP Negeri 4 Pakem.

METHODS

This research is a Classroom Action Research (CAR) using the spiral model of Kemmis and MC Taggart, which includes the stages of Planning, Implementation Observation, and Reflection. The planning stage includes coordinating activities for the teaching team, observers, and documentation to make action plans and develop learning tools, online learning facilities, learning observation instruments, and HOTS assessment questions. At the implementation stage, learning using a discovery learning model assisted by electronic worksheets based on Google Docs is applied according to previous preparations. The learning process starts from the first cycle as a basis for comparing with the next. Observation is carried out together with action by observing carefully and systematically recording the phenomena that occur in the research object. The results of observations become the basis for reflection. Reflection is done by reviewing the learning process that occurs in the classroom. The results of the reflection are used for improvement in the next cycle. Schematically, the research steps are presented in Figure 1.

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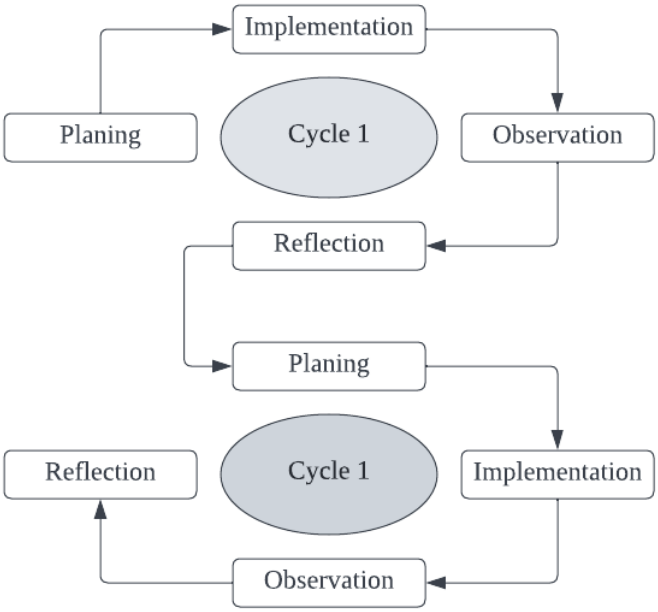

Gambar 1. Model Spiral Kemmis dan MC Taggart

This research was conducted at SMP Negeri 4 Pakem, with the research subject being 32 odd semester class VIII A students in the 2021/2022 academic year aged 13-14 years, with 14 male students and 18 female students. Data were collected using observation techniques, written tests, and documentation. The instruments used include learning instruments in the form of a syllabus, lesson plans (RPP), and electronic worksheets based on Google Docs. An observation sheet of learning implementation data is used as a checklist of learning activities following the stages of the discovery learning model, which includes the stimulation stage, problem statement, data collection, data processing, verification, and generalization (Hosnan, 2014). The pre-test and post-test questions were used to measure the students' HOTS abilities on the material of effort, power, and simple machines. Aspects of HOTS ability measured refers to (Anderson & Krathwohl, 2001), which include skills to analyze (C4), evaluate (C5), and create (C6). The pre-test and post-test questions used have been tested for validity and reliability using the Iteman software. The results of the validity and reliability analysis can be seen in Table 1.

Table 1. Validity and Reliability Item Test

Item Test	RBIs	Alpha	Validity	Reliability
Pretest/Posttest 1	0.497	0.729	Valid	High
Pretest/Posttest 2	0.210	0.312	Not Valid	Low
Pretest/Posttest 3	0.400	0.651	Valid	High
Pretest/Posttest 4	0.530	0.645	Valid	High

After the expert judgment, the item was revised according to the expert's suggestion and used in measurement as a valid question.

Indicators of success in this study: (1) The implementation of the Discovery Learning model can take place in the "excellent" category; (2) At least 75% of students reach the KKM of 80 for the HOTS ability score; (3) There is a significant difference between the pre-test and post-test scores of HOTS ability; and (4) the N-gain score of the HOTS ability test in the "medium" category. The learning implementation data were analyzed using Equation 1.

$$\alpha = \frac{\beta}{\gamma} \times 100\% \quad (1)$$

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where α is the percentage of implementation (%), β is the number of aspects implemented, and γ is a total of all aspects. Furthermore, the percentage of implementation is converted using the criteria according to Purwanto (2002), as shown in Table 2.

Table 2. Criteria of Learning Implementation

Percentages (%)	Criteria
86-100 %	Excellent
76-85 %	Very Good
60-75 %	Good
55-59 %	Fair
≤54 %	Poor

With the modification of equation 1, the percentage of students' learning completeness on the HOTS ability is analyzed using equation 2.

$$\varsigma = \frac{f}{\eta} \times 100\% \quad (2)$$

where ζ is the percentage of students' completeness, f is the number of students who pass the limit, and η is the total number of students. Moreover, a paired sample t-test was conducted to find the significant difference between the pre-test and post-test. Finally, an N-gain ($<g>$) analysis was carried out to determine the increase in the score using equation 3.

$$< g >= \frac{S_{post} - S_{pre}}{S_{\max} - S_{pre}} \quad (2)$$

The results of the N-gain calculation are interpreted using the criteria in Table 3 (Hake, 1991).

Table 3. N-Gain Category

Gain Score	Kategori
$<g> < 0.3$	Low
$0.3 \leq <g> \leq 0.7$	Moderate
$<g> > 0.7$	High

RESULTS AND DISCUSSION

The research was carried out in 2 cycles, each with 2 meetings. Following the classroom action research procedure, the stages carried out in each cycle consist of planning, action and observation, and reflection.

Cycle 1

1. Planing

The planning stage begins with determining the essential competencies used in research following the current curriculum at the time of the research in October – November 2021 for class VIII, namely essential competencies 3.3. Explain the concept of work, simple machines, and their application in daily life, including the work of muscles in the human skeletal structure. The instrument prepared is the Lesson Plan (RPP), and its completeness includes student worksheets, teaching materials, pre-test and post-test questions, and observation sheets. At the first meeting, learning uses a worksheet that contains activities related to business and power materials. In the second meeting, learning was carried out using a worksheet containing activities to find out the meaning of simple machines and classify their types and activities related to inclined planes.

2. Implementation and Observation

The learning activities began with an introduction, preconditioning, apperception, motivation, and a pre-test to measure initial abilities. In the core activity for the first meeting, the teacher provided

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stimulation in the worksheet. Then, students formulate problems and conduct an observation to collect data. In addition, the student process the data to answer questions and present the findings in front of the class. The core activity ends with students drawing conclusions related to the discussions that have been passed. Students respond well to the stimulation provided by the teacher, formulating problem questions well. Students can collect data and process it. At the proof stage, students make presentations and ask questions appointed by the teacher, and students seem to be able to make conclusions.

At the second meeting, the teacher gave stimulation in the form of people doing building construction and also pictures of people in wheelchairs who wanted to go up to a higher floor. Students are directed to observe pictures and conduct simple experiments with inclined planes to collect and process data to answer questions. Students present the results and make conclusions as in the first meeting. In this second meeting, the responses of students in learning were the same as in the first meeting. Students are active in working but still must be encouraged to ask questions and present the results.

The closing part of the two meetings in cycle I went relatively smoothly. The teacher gives appreciation and reflection to the students, and the students then do the post-test. At the end of the lesson, a student will lead the prayer, and the lesson ends with greetings. The data from the implementation of the first cycle can be seen in Table 4.

Table 4. Summary of Learning Implementation in Cycle I

Aspects	Score	
	First Meeting	Second Meeting
Pre-test	68.80	68.10
Post-test	72.90	75.00
Paired Sample T-Test Sig. (2-tailed)	0.269	0.070
N-Gain	0.15	0.03
Number of students who have not completed	21	11
Learning Achievement	34%	66%
Learning Implementation	66.6%	83.3%

The implementation of cycle 1 showed no significant difference between the pre-test and post-test scores in cycle 1, as indicated by the results of the paired sample t-test with the value of Sig. (2-tailed) which is more significant than 0.05. The resulting N-gain is also still relatively low.

3. Reflection

In the implementation of cycle 1, it was seen that there was an increase in learning completeness at the second meeting compared to the first meeting. Learning has been going well. However, in this cycle, the level of learning achievement for students has not reached 75%, so it still needs to be improved and continued in the second cycle. In addition, the value of N-gain in learning is still relatively low and decreased in the second meeting. The reason is that students are unfamiliar with the discovery learning model's steps, so it requires adaptation first, especially at the problem statement and verification stage. In addition, the level of material difficulty at the second meeting (sloping plane) was also higher than in the first meeting (effort and power), so the increase in the score of the second meeting was still low.

Cycle II

1. Enhanced Planning

In the second cycle, learning activities were planned in two meetings as in the first cycle. At the first meeting of the second cycle, learning uses a worksheet, which contains activities to observe the illustration of the pulley and the axle wheel, carry out data collection activities from the illustration, and then process the data obtained to design the pulley and axle wheel. At the second meeting of the second cycle, the plan is to use a worksheet, which contains activities using the Phet Simulation application to experiment with levers, and then group levers. Students process the data to find the mechanical advantages of levers and can also group levers. Students are also directed to analyze simple machines that exist in the human body.

There were several revisions of actions in cycle II based on the results of reflections in cycle I. First, the HOTS component further improved the worksheet by adding simple aircraft design activities

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in the first meeting and PhET virtual laboratory activities at the second meeting. Second, the material given to students is added to the difficulty level by adding material on the mechanical advantage of an axle wheel with a different axle at the first meeting. Meanwhile, at the second meeting, virtual laboratory activities were added. Then, the learning process emphasizes reflection after completing the learning activity.

2. Implementation and Observation

Activities in cycle II are carried out online, the same as in cycle I, with appropriate learning as in the lesson plan. In the introduction, it was done the same as in the first cycle. In the core activity of the first meeting, students were given problems about pulleys and problems related to farmers who wanted to make rice mills as stimulation. Students formulate a problem and then collect data from observing the illustration of a pulley and an axle wheel, then process the data to design a pulley and an axle wheel. Then, the results of the worksheet work are presented to the class, and the students conclude with the teacher.

At the first meeting, the activity went relatively smoothly from the beginning until it came to data collection. However, when processing data and making designs for pulleys and axle wheels, many students had difficulty making designs that matched what the questions wanted, so they needed help from students. Teacher. In the next stage, namely verification and concluding, students must be appointed by the teacher so that they want to present.

In the second meeting, the core activity began by providing stimulation in the form of problems related to children who wanted to play seesaw and the form of questions related to simple machines. Learners conduct experiments in Phet's virtual laboratory and simple group planes to collect data. Then, students process the data to find the mechanical advantages of levers and classify levers, verify the results of their work by presenting them in front of the class, and then make conclusions with the teacher. The second meeting went well, but students needed to be encouraged to ask questions and make presentations. In the closing stage, at the first and second meetings, the implementation is the same, namely by appreciating students who have learned, conveying reflections and conclusions from the learning carried out, providing material reinforcement, and doing post-tests. The data from the implementation of the second cycle can be seen in Table 5.

Table 5. Summary of Learning Implementation in Cycle II

Aspects	Score	
	First Meeting	Second Meeting
Pre-test	29.40	58.80
Post-test	51.90	80.60
Paired Sample T-Test Sig. (2-tailed)	0.00	0.00
N-Gain	0.31	0.50
Number of students who have not completed	24	7
Learning Achievement	25%	78%
Learning Implementation	100%	100%

The implementation of cycle II has increased significantly compared to cycle 1. At meetings 1 and 2, the paired sample t-test showed a significant difference between the pre-test and post-test scores in both meetings. The N-gain obtained is better than the low 1 cycle belonging to the medium group.

3. Reflection

Based on the results of learning observations in cycle II, there was a success, namely an increase in the value of students at meeting 4, with an average of 80.6. At meeting 4, the percentage of students' completeness exceeded the target of 78%. The increase in average score and %completeness in cycle II was due to the use of the worksheet, which had been more refined and the material provided had been enriched with elements of higher-order thinking.

In the second cycle, the first drawback is that students' learning outcomes dropped at the first meeting compared to the previous cycle because the material discussed was quite complex and higher than the basic requirements. In addition, activities in worksheets designing pulleys and axle wheels make it difficult for students. Then, improvements were made to the implementation of the second meeting of

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the second cycle, namely, to readjust the activities and materials in the worksheet to the student's abilities and to provide more concept reinforcement at the end of the lesson.

Stopping Cycle

Based on the results of observations during the learning process in the second cycle, the aspects of success have been achieved, namely: (1) the implementation of the discovery learning model can take place 100% or with an excellent category; (2) more than 75% of students reach the KKM of 80 for the HOTS ability score; (3) there is a significant difference between the pre-test and post-test scores of HOTS ability; and (4) the N-gain score of the HOTS ability test is in the medium category, so this CAR research is stopped in this second cycle.

Based on the study results, this classroom action research can be said to have achieved the established success indicators. Judging from the indicators of the implementation of learning, learning with the discovery learning model in cycle 2 has been implemented 100% or in the excellent category, as shown in Figure 2.

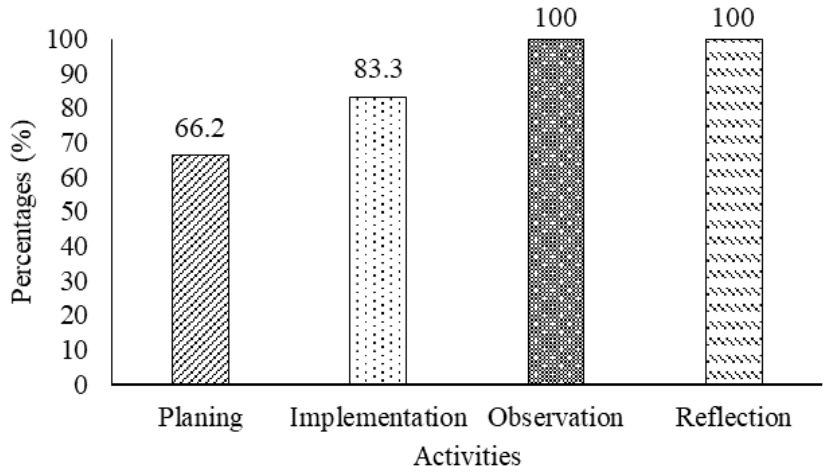

Figure 2. Implementation of learning at each meeting

According to Sukmasari and Rosana (2017), the activities in the discovery learning model are stimulation (stimulus/providing stimulation), problem statements (statements/problem identification), data collection (data collection), data processing (data processing), verification (proof), and generalization (concluding). Thus, the learning carried out in the classroom follows this sequence, and the teaching materials in the form of Google Docs-based electronic worksheets that are provided also follow the discovery learning syntax.

In the first stage, namely the stimulation stage, students are given problems by the teacher. Students then find the problem and present it. Then, in the worksheet, there are activities to collect data in the form of experimental activities, observations, and the like, in which then students are asked to enter data into the table provided. Then, students are asked to analyze the data and process it so they can answer questions related to the meaning of the data at the processing stage. Students will perform data processing, and teachers will provide guidance and assistance and direct students so they can process data. Students also present the findings in front of the class to obtain comments, suggestions, and verification. The last step is to conclude the learning carried out.

Judging from the percentage of the number of students who reached the KKM, it was seen that there was an increase from each meeting in both cycles. Even in the second female cycle 2, as many as 78% of students scored above the KKM. Judging from the difference in the value of the pre-test and post-test of HOTS abilities at the first and second meetings of cycle 2, there have also been significant differences based on the results of the paired sample t-test. In addition, the first and second meetings of cycle 2, seen from the N-Gain score, were also in the medium category. Although there was a decrease in test results at the first meeting of the second cycle, at the next meeting, learning outcomes increased sharply. The percentage of achievement of increasing HOTS and N-Gain scores from each meeting is shown in Table 6 and Figure 4.

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Table 6. Learning Achievement in each Cycle

Activities	%	
	Cycle 1	Cycle 2
Planing	0	34.00
Implementation	0	66.00
Observation	0	25.00
Reflection	0	78.00

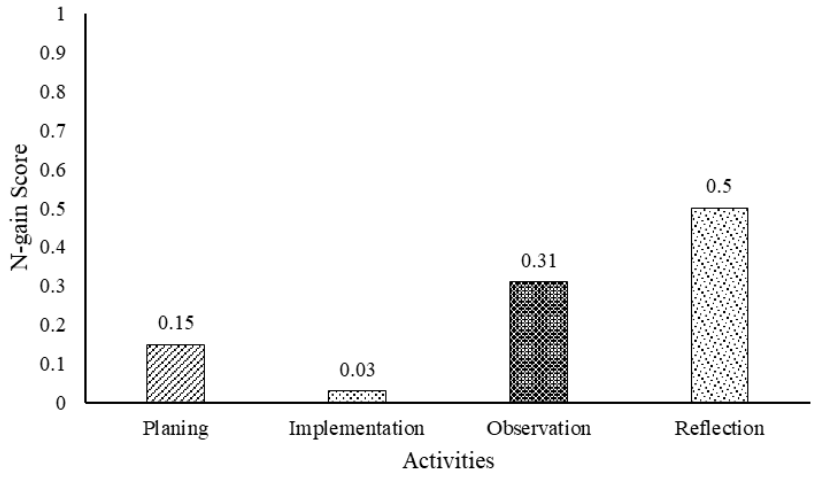

Figure 4. The N-Gain score for each activity

The results showed that applying the discovery learning model, assisted by electronic worksheets based on Google Docs, improved students' HOTS abilities. This finding is consistent with the results of studies conducted by Purwasi and Fitriyana (2020), Sari and Pradita (2018), and also Kholid Yusuf (2018). This increase is due to the discovery learning steps that facilitate students to develop their HOTS abilities. In this model, students are presented with problems engineered by the teacher so that students can analyze and draw conclusions (Abidin, 2013). Giving stimulation is followed by data collection, and students discover what they have learned. Providing stimulation through contextual problems will practice their ability to relate concepts to the situation (Widana, 2019). In the data collection and processing stage, it will also involve students' ability to the maximum to explore and identify so that they can find knowledge by themselves (Ustanti, 2020). This model also involves students thinking by observing, obtaining data from investigations, analyzing, and conveying results (Rahmawati et al., 2021). Students will be asked to make problem-solving, and from there will emerge the ability to analyze, evaluate and create (Untari et al., 2018). The emergence of the ability to analyze, evaluate, and create will increase students' HOTS abilities.

The increase in HOTS capability is also supported using an electronic worksheet based on Google Docs. The arrangement of worksheets following discovery learning supports the implementation of discovery learning to make students find their understanding. This worksheet's various activities, tasks, and questions are oriented toward HOTS abilities. This follows the opinion of Pratiwi & Alimuddin (2018) that the use of teaching materials with HOTS content makes students carry out learning activities oriented to higher-order thinking skills. The elements in the HOTS-charged worksheets will practice and familiarize students to think at higher levels (Noprinda and Soleh, 2019). In addition, in these worksheets, there are activities in the form of designing problem-solving and experiments with virtual Phet simulations. The discussion activities carried out in assignments in the worksheets also encourage students to think at a higher level, according to a study conducted by Pamungkas (2018). Higher-order thinking skills such as connecting, manipulating, and transforming knowledge (Rofiah et al., 2019) are used in these tasks. In the end, the learning experience in worksheets will improve students' ability to solve HOTS category questions (Linda et al., 2019).

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CONCLUSION

This study concluded that applying the discovery learning model assisted by electronic worksheets based on Google Docs could improve students' HOTS abilities. In cycle 2, the implementation of learning has reached 100% or is categorized as very good. In addition, applying the discovery learning model assisted by electronic worksheets based on GoogleDocs can improve HOTS abilities in class VIII A students of SMP Negeri 4 Pakem. In cycle 2, as many as 78% of students achieved the KKM of 80 from the post-test results of HOTS abilities. There was a significant difference between the average pre-test and post-test scores, and the N-gain score was moderate.

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